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OPTICAL CONNECTION MODULE

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ABSTRACT
PURPOSE: To provide an optical connection module capable of making an interconnection between fibers on an array substrate with simple operation without requiring high accuracy in arrangement of fibers and relative positions of the array substrate.

CONSTITUTION: An end of an optical fiber 3 of one array substrate A and a rotatable reflection mirror 8 of the other array substrate B are faced at a constant interval with each other using the array substrates A and B in which the optical fiber 3 and a rotatable reflection mirror 8 are arranged two- dimensionally. Light from the optical fiber 3 of the array substrate A is reflected on the rotatable reflection mirror 8 of the array substrate B, and the light is applied to the optical fiber 3 or rotatable reflection mirror 8 on the opposed array substrate A to connect any optical fibers to each other.

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(54) [Name of invention]: Optical Connection Module

(57) [Extent of the Patent Application]

[Application 1] An optical connection module; that uses boards each equipped with a two-dimensional array of optical fibers, mirrors that each individually rotates around the two axes of vertical and horizontal directions and additionally has light receiving elements among them; has a pair of boards set at a constant distance so that optical fibers from one board face reflective mirrors of the other board; that detects the light position with the said light receiving elements by reflecting the light emitted from an optical fiber on one board with a reflective mirror on the other, and by directing this light to an optical fiber or a reflecting mirror on the opposing board, establishes optical connection between arbitrary optical fibers.

[Detail Description of the Invention]

[0001]

[Applicable Fields of the Industry] This invention relates to optical connection modules for switching optical signals among multiple optical fibers in the field of optical communication.

[0002]

[Related Art] For spatial connection of switching optical signals between two-dimensional fiber arrays, a conventional structure consists of several beam shifters 2 placed between boards 1 arranged with two-dimensional fiber arrays, as Fig. 4 shows. With this structure, micro lens 4 converts the light from optical fiber 3 into a parallel light beam 5, which then passes through all beam shifters 2 to finally reach the other fiber array. Light beam 5 may change its direction when it passes through beam shifter 2 depending on presence of electrical signal; the redirected beam shifts only by one section, divided within beam shifter 2. Thus, a number of beam shifters are necessary for large change of the beam path. For example in Fig. 4, for connecting the corner fiber of the two-dimensional fiber array 1 at one side to the fiber located at the diagonal position on the other fiber array requires eight beam shifters. The presence of many parts in the spatial connection between two optical fibers not only increases the light loss between the fibers, but has the problem of requiring high precision in setting relative positions among two-dimensional fiber arrays 1 and beam shifters 2.

[0003]

[Problem the Invention Solves] This invention provides an optical connection module that solves the said problem by using two rotating reflective mirrors.

[0004] The optical connection module of this invention uses boards with two-dimensionally arranged optical fibers and mirrors that rotate independently around the vertical and horizontal axes, and additional light receiving elements among them; the boards are placed, at a set distance, facing each other with ends of optical fiber on one board facing reflective mirrors on the other; the light receiving elements detect the light position to reflect the light from an optical fiber from one board to a reflective mirror on the other to cast the light to another optical fiber or a reflective mirror on the other board; this establishes optical connection

between arbitrary optical fibers.

[0005]

[Sample Implementation] This section explains a sample implementation of this invention in detail. Fig. 1 shows an angled sketch of the basic structure of the array board of optical fibers and rotating reflective mirrors arranged in two-dimension, where 3 is an optical fiber, 4 a micro lens on the micro lens board, 6 an opening for installing a rotating reflective mirror on the micro lens board, 7 a board with micro lenses installed, 8 a rotating reflective mirror that rotates around two axes, and 9 the array board that houses fibers 3 and rotating reflective mirrors 8 in a two-dimensional array. The micro lens 4 faces the end of the optical fiber 3 and converts the light emission into a parallel light beam. The rotating reflective mirror 8 independently rotates around the vertical and horizontal axes and it can be turned to an arbitrary direction.

[0006] Fig. 2 shows an angled view of the basic structure of the optical connection module with the fiber array turned for easier understanding of the connection between array boards A and B (micro lens board 7 is not shown). In the actual setting, the array board A has its fibers and rotating reflective mirrors facing the rotating reflective mirrors and fibers of array board B at a constant distance in parallel.

[0007] With this structure, for connecting the i-th fiber Fa(i) of array board A and the j-th fiber Fb(j) of array board B, the rotating mirror Mb(i) facing fiber Fa(i) sets its angle so that the light from fiber Fa(i) hits the j-th rotating reflective mirror Ma(j) of the array board A, and similarly, the rotating reflective mirror Ma(j) adjusts to reflect the reflection beam from the rotating reflective mirror Mb(i) to fiber Fb(j).

[0008] If the reflection beam from rotating reflective mirror Ma(j) points to, instead of fiber Fb(j), a rotating reflective mirror Mb(k), which then reflects the beam to Fa(k), the light from array board A connects to another optical fiber on the same board. In other words, using two reflective mirrors produces a spatial connection with an arbitrary fiber of the array board facing the one emitting the beam and using three, a connection with an arbitrary fiber on the same array board that is emitting the beam. A connection that uses only one reflection mirror is possible between fibers on the same board, however, light transfer is limited to one direction as the light enters at an angle.

[0009] Including the spatial connection that returns the beam emitted from fiber Fa(i) back to the original fiber Fa(i) as the reflection beam from the rotating reflective mirror Mb(i), the optical connection module of this invention can accomplish mutual spatial connection for all optical fibers that construct the module including self connection.

[0010] The optical loss with this spatial connection is hardly affected by the path or length of optical connection, with only the reflectance of two to three reflective mirrors requiring consideration, and high reflectance film that has been widely used makes the optical loss small. Also, using low reflectance film lowers the effect of Fresnel reflection fringe upon the light passing through micro lenses.

[0011] Also, the relative position of array boards A and B and each fiber position on the array boards do not require high precision requiring only proper positioning so the light beam emitted from fiber Fa(i) always hits the rotating reflective mirror Mb(i). The reason is, in transferring the light received by rotating reflective

mirror Mb(i) via rotating reflective mirror Ma(j) to fiber Fb(j), the connection is established by adjusting the rotating reflective mirror angles no matter what the other positions are.

[0012] However with this method, finding the beam position on the array board takes detecting the light beam position by hitting a light beam on the fiber. Then, if all fibers other than the intended one are already connected not allowing hitting another light beam to any other fiber, the beam position detection is difficult.

[0013] Fig. 3 shows the front view of the array board of a module structure similar the previous one that allows detecting the light beam position by setting a light receiving element 10 between the fiber end and the rotating reflective mirror on the two-dimensional array board. This array board allows hitting the light beam to the intended mirror or fiber in the following manner.

[0014] First, hit light beam 5 to an arbitrary light receiving element 10 on the opposing array board and find the light beam position P_1. Next, calculate the position of the intended fiber F_0 or mirror M_0 (not shown) and scan the light beam. Here in scanning the light beam, instead of moving the beam directly to the intended fiber F_0, first detect the light beam position with one of the four light receiving elements 10' placed around the fiber F_0 and then scanning the light beam to fiber F_0 precisely hits light beam to the target F_0 because fiber F_0 and light receiving elements 10' are relatively close.

[0015]

[Effect of Invention] As explained above, the optical connection module of this invention, in establishing mutual connection between optical fibers of the array boards, only uses two rotating reflective mirrors facing the fibers for changing and setting the light path; is easy to operate; and has small light loss. Also, combinations of fibers already connected are changed in the same manner. The fiber array and array boards do not require high precision in relative positioning so the effect of easy fabrication and assembly is expected.

[Brief Description of the Figures]

[Fig. 1] An angled view sketch of the basic structure of the array board with optical fibers and rotating reflective mirrors arranged two-dimensionally.

[Fig. 2] Sketch that shows the spatial connection state of light using two array boards.

[Fig. 3] Front view of an array board that allows detecting the light beam position by placing a light receiving element between the fiber end and the rotating reflective mirror for the two-dimensional array board.

[Fig. 4] An angled view sketch that shows the structure of a two-dimensional optical connection module that uses beam shifters.

[Description of Symbols]

1 Two-dimensional fiber array board
2 Beam shifter
3 Optical fiber
4 Micro lens
5 Light beam
6 Opening
7 Micro lens board

8 Rotating reflective mirror

9 Array board

10, 10' Light receiving element

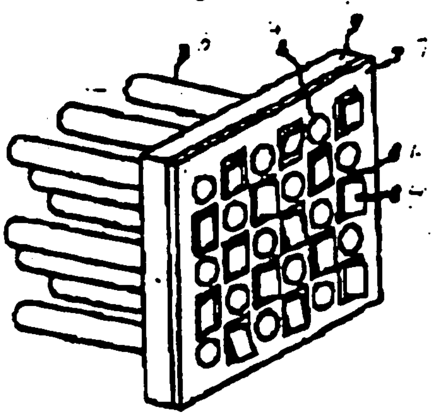
A, B Array board

Fo, Fa(i), Fa(k), Fb(l) Fiber

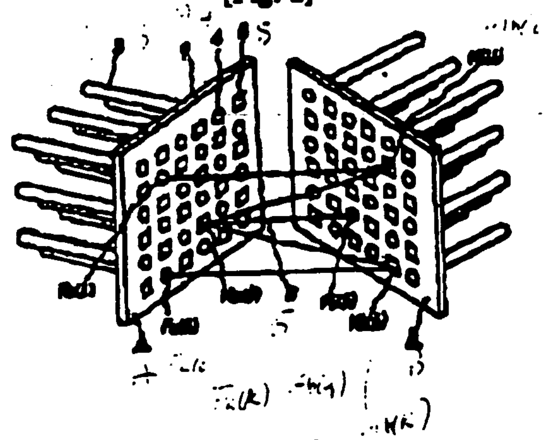
P1 Light beam position

Mb(i), Ma(j), Mb(k) Rotating reflective mirror

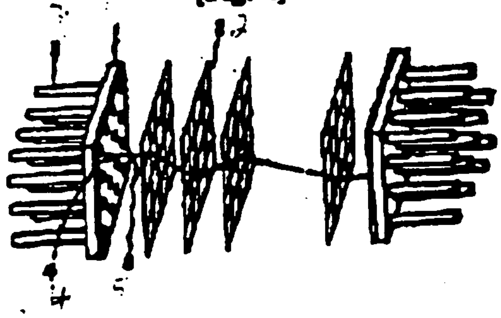
[Fig. 1]



[Fig. 2]



[Fig. 4]



[Fig. 3]